

INSTITUTE AND FACULTY OF ACTUARIES

EXAMINERS' REPORT

September 2018

Subject ST9 – Enterprise Risk Management

Introduction

The Examiners' Report is written by the Principal Examiner with the aim of helping candidates, both those who are sitting the examination for the first time and using past papers as a revision aid and also those who have previously failed the subject.

The Examiners are charged by Council with examining the published syllabus. The Examiners have access to the Core Reading, which is designed to interpret the syllabus, and will generally base questions around it but are not required to examine the content of Core Reading specifically or exclusively.

For numerical questions the Examiners' preferred approach to the solution is reproduced in this report; other valid approaches are given appropriate credit. For essay-style questions, particularly the open-ended questions in the later subjects, the report may contain more points than the Examiners will expect from a solution that scores full marks.

The report is written based on the legislative and regulatory context pertaining to the date that the examination was set. Candidates should take into account the possibility that circumstances may have changed if using these reports for revision.

Mike Hammer
Chair of the Board of Examiners
December 2018

A. General comments on the *aims of this subject and how it is marked*

1. The aim of the Enterprise Risk Management (ERM) subject is to instil in successful candidates the key principles underlying the implementation and application of ERM within an organisation, including governance and process as well as quantitative methods of risk measurement and modelling. The student should gain the ability to apply the knowledge and understanding of ERM practices to any type of organisation.
2. The ST9 exam generally requires bullet point form or short form essay style answers that apply general principles to directly address specific circumstances. The answers given below are just one possible set of acceptable answers.
3. Candidates are awarded marks for all reasonable answers including different but still reasonable numerical solutions. Marks are awarded for working in the case of numerical answers.
4. Candidates' answers are made up of a series of points. For example, a point can be stating a valid type of risk, describing the type of risk or (part of) a calculation.
5. Candidates who give well-reasoned points, not in the marking schedule, are awarded marks for doing so.

B. General comments on *student performance in this diet of the examination*

Many students performed well in this diet. Knowledge based questions were generally (but not universally) well-answered. The key challenges seemed to be in several areas. First, where a process was to be described, candidates often struggled to outline all of the steps required. There was also an issue with a sufficiently broad range of points being generated in some questions. Finally, application questions involving copulas offer the opportunity to score full marks, but many students were unable to answer such questions successfully.

C. Pass Mark

The Pass Mark for this exam was 62.

Q1

(i)

- Lotlot's aim is to make as much profit as possible to benefit charities... [0.5]
 - ...and supply guaranteed prizes [0.5]
 - Ticket fees and investment returns are the only sources of income [1]
 - Lotlot is relatively unconcerned with profit volatility... [0.5]
 - ...as long as profit is greater than 0 i.e. running costs are covered each year [0.5]
 - Therefore can take a riskier investment strategy than many other companies [0.5]
 - However if charities come to rely on Lotlot donations there may be some pressure to smooth profits [0.5]
 - Also, Lotlot's strategy must be set such that it has to make sure it meets the guaranteed prizes it must pay [1]
 - Derivatives can be used for hedging or speculative investments [0.5]
 - so are an appropriate investment [0.5]
 - Equities and bonds provide regular payments [0.5]
 - Coupons and dividends [0.5]
 - Which can be used to contribute to running costs [0.5]
 - Equities and bonds may also provide profits [0.5]
 - Maximum loss is the initial investment for bonds and equities [0.5]
 - The asset types are very liquid [0.5]
 - Equities and derivatives as they are exchange tradeable [0.5]
 - Bonds more or less marketable depending on the government [0.5]
 - but they are short duration so more liquid than long duration [0.5]
 - Important to meet the regular cash outflow – prizes and running costs [0.5]
 - For derivatives the loss may exceed the initial investment [0.5]
 - This is more likely if derivatives are used as a speculative investment [0.5]
 - Equities and derivatives typically have relatively volatile but relatively high profits [0.5]
 - Strategy requires high level of expertise [0.5]
 - Lotlot's investment strategy is only concerned with upside risk [0.5]
 - It makes no condition/set no limits on the downside risk [0.5]
- [Maximum 10]

Whilst some candidates answered this question well, many failed to generate a wide enough range of points.

(ii)

- The value of risk is the maximum loss expected... [1]
- ...with a particular degree of confidence... [0.5]
- ...over a specified time horizon [0.5]
- The outcome could be absolute or relative [0.5]
- The tail value at risk is the expected loss... [0.5]
- ...given that a loss beyond a particular critical value has occurred... [1]
- ...over a specified time horizon [0.5]
- The probability of ruin is the probability that the net financial position of an organisation falls below zero... [1]
- ...over a given time horizon [0.5]

- It is also the reciprocal of VaR [0.5]

Alternatively, formulae may be given, for full marks:

- Value at Risk:

$$\text{VaR}_\alpha = L_{X,T\alpha}.$$

Where

$$L_{X,t} = -(X_t - X_{t-1})$$

(Can also give in terms of gains, i.e. with losses being negative gains)

- Tail Value at Risk:

$$\text{TVaR}_\alpha = \frac{\sum_{t=T\alpha}^T L_{X,t}}{\sum_{t=T\alpha}^T I(t \geq T\alpha)}$$

(loss distribution as defined above)

Probability of ruin: $P(LX, t > 0)$

[Maximum 5]

This question was generally well-answered by candidates.

(iii)

Both

- Can give a true indication of risk whatever the underlying distribution of results [0.5]
- Easy to calculate if the underlying model is a normal distribution... [0.5]
- ...or from the simulated output [0.5]
- May be subject to model risk depending on how calculated [0.5]
- One-sided risk measures... [0.5]
- ...so reflects downside risk rather than just uncertainty [0.5]
- It could also be argued that too high a confidence interval would draw attention away from less extreme but more likely scenarios [0.5]

VaR

- Is easy to interpret [0.5]
- But does not reflect the risk beyond the critical value [0.5]
- Not a coherent risk measure [0.5]

TVaR

- Is less easy to interpret [0.5]
- Coherent risk measure [0.5]
- Reflects the average of the worst losses... [0.5]
- ...so considers what is happening past the critical value [0.5]
- However, it could be argued that within an already-small tail, there is too much uncertainty to set much store by what happens in the tail [0.5]

[Whole marks for “comparative points”; Maximum 5]

This question was generally well-answered by candidates, though many failed to generate a sufficient number of points. As this is largely knowledge based, there was ample potential to score full marks.

(iv)

- The regulator is more concerned with whether the company will go bust [1]
- Var defines the maximum amount that will be lost... [0.5]
- ...rather than the likelihood of insolvency [0.5]
- ...than the amount of capital needed to bring the expected amount of loss down to a particular level [0.5]
- ...therefore more interest in probability of ruin [0.5]

[Maximum 2]

The question was generally well-answered.

(v)

- Lottery probably played frequently (or suggested time horizon) which suggests a short time horizon [0.5]
- It depends on the frequency with which the lottery played [1]
- However may take longer than a week to change asset position [0.5]
- And may take longer than a week to change cashflows [0.5]
- For example cannot leave an office to cut rent [0.5]
- or cut staff in a week [0.5]
- or advertising may increase income but not take effect instantly [0.5]
- Suggest 1 month [0.5]

[Marks for any reasonable time horizon with reasons, although expect less than 1 year, max 1 mark for examples of fixed-type cash flows]

[Maximum 2]

Few candidates scored well on this question, with many scoring no marks at all. This question did require higher order skills, but there was scope to score at least some marks easily.

(vi)

Minimise risk of asset and income losses [max 2]

- Use derivatives to hedge the equity exposure [0.5]
- For example, use swaps or swaptions to reduce bond losses caused by interest rate changes [0.5]
- Or futures (where available) to reduce equity losses [0.5]
- Only invest in high rated government bonds [0.5]
- Only invest in high rated equities [0.5]
- Reduce the allocation to equities [0.5]
- Increase diversification between asset classes [0.5]
- Increase diversification within asset classes [0.5]

Minimise risk of high outgo [max 2]

- Hold a reserve rather than giving all profits to charity [1]
- Reduce running costs (people, infrastructure,...) [0.5]
- Move headquarters to a cheaper office location [0.5]
- Hire more temporary or casual workers and less permanent staff on fixed [0.5]

- Any reasonable examples [0.5 each]
- Minimise risks of outgo exceeding income*
- Move from guaranteed to variable prizes... [1]
 - ...including limiting size of prizes to be less than ticket income e.g. total prizes each week are only 75% of ticket income [0.5]
- Improve risk management*
- Better monitoring/reporting/early warning of risk [0.5]
 - Increased used of risk limits [0.5]
 - Raise capital [0.5]
 - Any reasonable examples [0.5 each]
- [Maximum 6]

This question was generally well answered.

- (vii)
- Systematic risk is risk that cannot be eliminated through diversification... [1]
 - ...or cannot be fully diversified... [0.5]
 - ...because it affects a large number of quantities of interest [0.5]
 - Or Systematic risk occurs when many firms are similarly affected by a particular external risk... [0.5]
 - ...either directly or through relationships with each other. [0.5]
- [Maximum 2]

This knowledge based question was well answered by most candidates.

- (viii)
- Lotlot's assets are invested on the stock exchange... [0.5]
 - ...So systematic risk from the stock exchange as a common counterparty [0.5]
 - e.g. liquidity issues at the same time as every other company trading on the stock exchange – common market position [0.5]
 - Lotlot's customers are online... [0.5]
 - ...So systematic risk from the internet infrastructure in the country [0.5]
 - e.g. a national internet virus or failure impacts every business and individual at the same time [0.5]
 - Lotlot's business involves several financial transactions – online sales, asset investments, prize payouts... [0.5]
 - ...So systematic risk from the central banking system / financial infrastructure [0.5]
 - E.g. a failure in any part of the banking system like collapse of a big bank reduces trust in and effectiveness of in the banking system [0.5]
- [Maximum 4]

Despite being able to define systematic risk, many candidates failed to give relevant examples. This often involved candidates giving a general example of systematic risk without linking it to Lotlot's circumstances.

(ix)

- Probability of ruin may be reduced from investing in more secure assets [0.5]
 - Any change would incur transaction costs, so would reduce reserves [0.5]
 - Whether these bonds are more or less secure depends on their rating (if they are rated) [0.5]
 - Lotlot may be still looking for more short-term profits, so long term bonds may not be appropriate [0.5]
 - Long term bonds can be slightly less liquid so liquidity issues may be exacerbated [0.5]
 - Ruin may occur due to lack of cash when required even if assets exceed liabilities overall [0.5]
 - However still run through the same financial system so some systematic risk still exists [1]
 - Market risk may have reduced via diversification [0.5]
 - but the nature of systematic risk means it cannot be reduced by different assets [0.5]
- [Maximum 4]

[Total 40]

This question was not particularly well answered, with candidates failing to give the number of distinct points required to score well.

Q2

(i)

- Any risk of financial loss... [0.5]
- ...disruption... [0.5]
- ...or damage to the reputation of an organisation... [0.5]
- ...from some sort of failure of its information technology systems... [1]
- ...typically where there is online activity... [0.5]
- ...or storage of personal data [0.5]

[Maximum 2]

Whilst this question was generally well answered, some candidates focussed on too narrow a definition of this risk.

(ii)

- Significant risk for Sunshine... [0.5]
- ...as only sales channel is online [1]
- Website crashes leading to lost business [1]
- Hacked systems leading to loss of confidential data and reputational damage [1]

(Any two relevant examples)

[1 mark for each, must include both event and impact of event]

[Maximum 3]

This question was well-answered.

(iii)

- Define different types of event (e.g. denial of service, ransomware, fraud, system failure) [1]
- Collect data on previous cyber events... [0.5]
- ...either at own company... [0.5]
- ...or from industry data... [0.5]
- ...or reinsurer [0.5]
- Consider potential scale of losses at SSSIC for these types of events... [1]
- ...based on own mix of business... [0.5]
- ...estimated downtime... [0.5]
- ...likely losses from loss of future business [0.5]
- Need information on both frequency and severity [1]

[Maximum 6]

Whilst some candidates answered this question well, many struggled to come up with enough distinct points in the process.

(iv)

- Increased IT security like virus scans, malware protection and firewalls [1]
- Buy cyber insurance e.g compensation for reputational damage [1]

- Increase robustness, e.g. unstage backup servers [1]
 - Diversify away from cyber e.g. to phone, direct selling [1]
 - (Any other relevant example) [1]
- [Maximum 2 marks – must have generic plus specific point]

This question was well-answered.

(v)

- Similar business may mean similar systems... [1]
- ...or even the same (outsourced) system... [0.5]
- ...so open to similar software vulnerabilities... [0.5]
- ...and behavioural vulnerabilities (e.g. phishing)... [0.5]
- ...so similar types of attacks may affect all firms [0.5]
- Also, hackers may know this... [0.5]
- ...so may target similar firms [0.5]
- Furthermore, some attacks so widespread that all firms risk being affected, not just insurers [0.5]

[Maximum 3]

This question was generally well-answered.

(vi)

- Use generator function

| | |
|--------------------|---------------------------------|
| | |
| Sunshine insurance | $[-\ln(0.9987)]^2 = 0.00000169$ |
| Flyaway insurance | $[-\ln(0.9635)]^2 = 0.00138256$ |
| Everyone insurance | $[-\ln(0.9821)]^2 = 0.00032624$ |

[0.5 marks per part, plus bonus 0.5 for all 3]

Joint probability function:

$$\text{Exp}\{-[(-\ln(F(\text{Sunshine})))^\alpha + (-\ln(F(\text{Flyaway})))^\alpha + (-\ln(F(\text{Everyone})))^\alpha]^{1/\alpha}\} \quad [1]$$

$$\text{Exp}\{-(0.00000169+0.00138256+0.00032624)^{1/2}\}$$

$$= \text{Exp}\{-0.041358109\}$$

$$= 0.959485$$

[1]

[Maximum 4]

This straightforward copula question was poorly answered. These types of application questions offer easy marks for well-prepared candidates.

(vii)

- Bias as the company is determining its own threshold... [0.5]
 - ...and probability of exceeding threshold [0.5]
 - Bias as the company may not record all instances [0.5]
 - Bias as the company is determining its own future probability so may exclude some event [0.5]
 - Inconsistencies in definition of event caused by cyber risk [1]
 - Past experience may not be best indicator of future [1]
 - May increase controls and better processes as a result of past events, for example [0.5]
 - Model risk – how was the copula determined? [0.5]
 - Gumbel copula has upper tail dependence, which may be overly conservative [0.5]
 - Parameter risk – was there enough data available to derive the parameter? [0.5]
 - Only a single parameter regardless of number of companies [0.5]
- [Maximum 4]

This question was not well-answered. Again, the main challenge seemed to be generating a wide enough range of points.

(viii)

- Extreme value theory [1]
- if frequency is low... [0.5]
- ...and excluding small instances as in the approach above (so that severity is high) [0.5]
- However, this requires a reasonable history of data to fit a model... [0.5]
- ...and this might not be available for a relatively new risk such as cyber... [0.5]
- ...although proxies might be available from industry... [0.5]
- ...or reinsurers [0.5]

Or

- Scenario analysis [1]
 - A wide range of events leading to different losses would be considered [0.5]
 - Scenarios leading to significant losses could include combinations of events [0.5]
 - Generating events and scenarios requires some expertise [0.5]
 - and this could be limited for a relatively new risk such as Cyber risk [0.5]
 - although industry databases/examples may be available [0.5]
- [Maximum 3]

This question was only moderately well-answered, The risk involved limited data and low probability events, which should have clearly suggested extreme value theory or scenario analysis.

(ix)

- Upside risk of increased sales [1]
- Insurance is now compulsory so more potential sales [0.5]
- Potential to increase revenue [0.5]

- Reduced adverse selection [0.5]
 - Those who consider themselves less likely to claim through good health, good organisation... and didn't previously buy travel insurance now have to [0.5]
 - Overall book of policyholders less likely to claim [0.5]
 - Pricing risk – assumptions based on historical data no longer appropriate as new mix of policyholders [0.5]
 - Operational risks associated with increased transactions [0.5]
 - e.g. additional errors, slower processing time... [0.5 marks for each example, max 1]
 - Increased competition from other companies as the insurance is now compulsory [0.5]
 - Sunshine may need to offer lost luggage and cancellations as riders or separate policies rather than part of the main policy as the compulsory part is medical insurance cover. [0.5]
 - This increases the administration overhead and scope for operational errors [0.5]
- [Maximum 6]

Most candidates made a reasonable attempt at this question.

(x)

Advantages

- Encourages fewer claims – promise of cheaper insurance in the future [1]
- i.e. reduces moral hazard [0.5]
- Encourages repeat business – acts like a loyalty bonus (assuming the NCD is not transferable) [0.5]
- Already keep historical data for pricing so little additional overhead costs [0.5]

Disadvantages

- Increased administration costs and [0.5]
 - Scope for errors [0.5]
 - Reduced revenue on policies that would have renewed without the NCD [0.5]
- [Maximum 3]

[Total 36]

This question was generally well-answered by candidates

Q3

(i)

- Pillar 1 Minimum capital requirement [1]
 - Cover market, credit and operational risk [1]
 - Internal ratings based approach allowed for credit risk [0.5]
 - Internal model and scenario analysis allowed for operational risk [0.5]
 - Risk weighted assets multiplied by a minimum capital requirement [0.5]
 - Risk weights based on a 99% ten day VaR [0.5]
 - Pillar 2 Supervisory review process [1]
 - Including review of internal processes for monitoring capital solvency [0.5]
 - Pillar 3 Market discipline [1]
 - Requirement to publish details or risks, capital and risk management [0.5]
- [Maximum 6]

This question was well-answered.

(ii)

- BB being Basel compliant means it can do business [1]
 - XYZ Bank can be confident that BB bank has robust risk management processes in place [1]
 - Some information is already published so do not need to request it [0.5]
 - Industry standard risk measurement practises [1]
 - Common risk measurement practices (if both are using the standardised approach) [0.5]
 - Likely lower costs to integrate the two banks as more common approaches [0.5]
 - Easier to aggregate risks and estimate joint capital requirement [0.5]
- [Maximum 3]

This question was well-answered by candidates.

(iii)

- BB products are a subset of XYZ products so the difference in risks is those that diversify away at national level
 - Concentration risk – anything that depresses the local economy e.g. [0.5]
 - ...Loss of public transport in the area [0.5]
 - Business risks impacting the local economy e.g. [0.5]
 -Relocation of a significant business out of the area [0.5]
 - ...Loss of a significant local industry in the area [0.5]
 - All of these could decrease deposits and/or increase defaults on the loans in the BB bank area but would have no or little impact on XYZ – any reasonable example
 - Operational risks specific to BBs local area that interrupt business e.g. [0.5]
 - ...Flood of local river
- [Maximum 2]

This question was well-answered by candidates.

(iv)

- Gather and collate relevant inputs [0.5]
- e.g. last few years financial information on BB bank [0.5]
- ... and business plans for next few years for BB bank... [0.5]
- ...and estimated transaction cost [0.5]
- Aggregate this data with XYZ bank's data [0.5]
- Consider the impact on interactions between risks which may be estimated [1]
- ...so may need to consider ranges [0.5]
- Carry out calculations [0.5]
- like cash flow projections [0.5]
- Consider key features/metrics e.g. profitability of the combined group [1]
- ...liquidity [0.5]
- ...stability of profits/earnings [0.5]
- ...capital requirements [0.5]
- ...risk metrics [0.5]
- Under a variety of scenarios determined internally [0.5]
- Or run several simulations [0.5]
- Produce outputs for analysis [0.5]
- Include ranges, sensitivities and/or stochastic distribution [0.5]
- Compare with XYZ projections excluding BB bank [1]
- Compare risk profile output to risk appetite [1]
- Compare output to hurdle rates (mark for any other criteria e.g. target rate of return) [1]
- XYZ use to determine whether to pursue a project [1]
- Present output to Board/Committees (mark for any appropriate governance procedure) [1]
- Review and discuss [0.5]
- ...to assess whether additional risk is outweighed by additional benefit... [0.5]
- ...and whether this proposal fits with XYZ strategy [0.5]

[Maximum 9]

As with the process question earlier in the paper, candidates struggled to give sufficient detail on the points required.

(v)

Economic Income generated

- Risk adjusted return – (hurdle rate x economic capital) [OR (Risk-adjusted return – hurdle rate) x economic capital] [1]
- Measures how much return is generated [0.5]
- Compare to hurdle rate set for any new project [0.5]

Shareholder Value Added

- Present value of all future cashflows in excess of the economic capital consumed or Economic capital x [(risk adj return on capital – growth)/(hurdle rate – growth) – 1] [1]
- Measures how much return is generated in excess of the hurdle rate allowing for a longer time period [0.5]

- Compare to alternatives [0.5]

Risk adjusted return on capital

- Risk-adjusted return / economic capital [1]
- Not uniquely defined (several versions of RAROC) [0.5]
- Compare to RAROC on other projects or current RAROC [0.5]

[Maximum 2 metrics, maximum 2 marks per metric; Maximum 4]

[Total 24]

This question was generally well-answered by candidates.

END OF EXAMINERS' REPORT